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LUMINARY Memo # 118

To: Distribution
From: D. Eyles
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Subject: Landing Changes Put Into LUMINARY 1C

Four changes that affect the landing were made for LUMINARY 1C:

(1) After a restart STILBADH and STILBADV, if they contain zero, are incremented to prevent incorporation of the next landing radar altitude and velocity readings. This is because if a restart occurs during a (80 ms) radar read this read is stopped and the next read consists of its remaining portion - and thus is wrong.

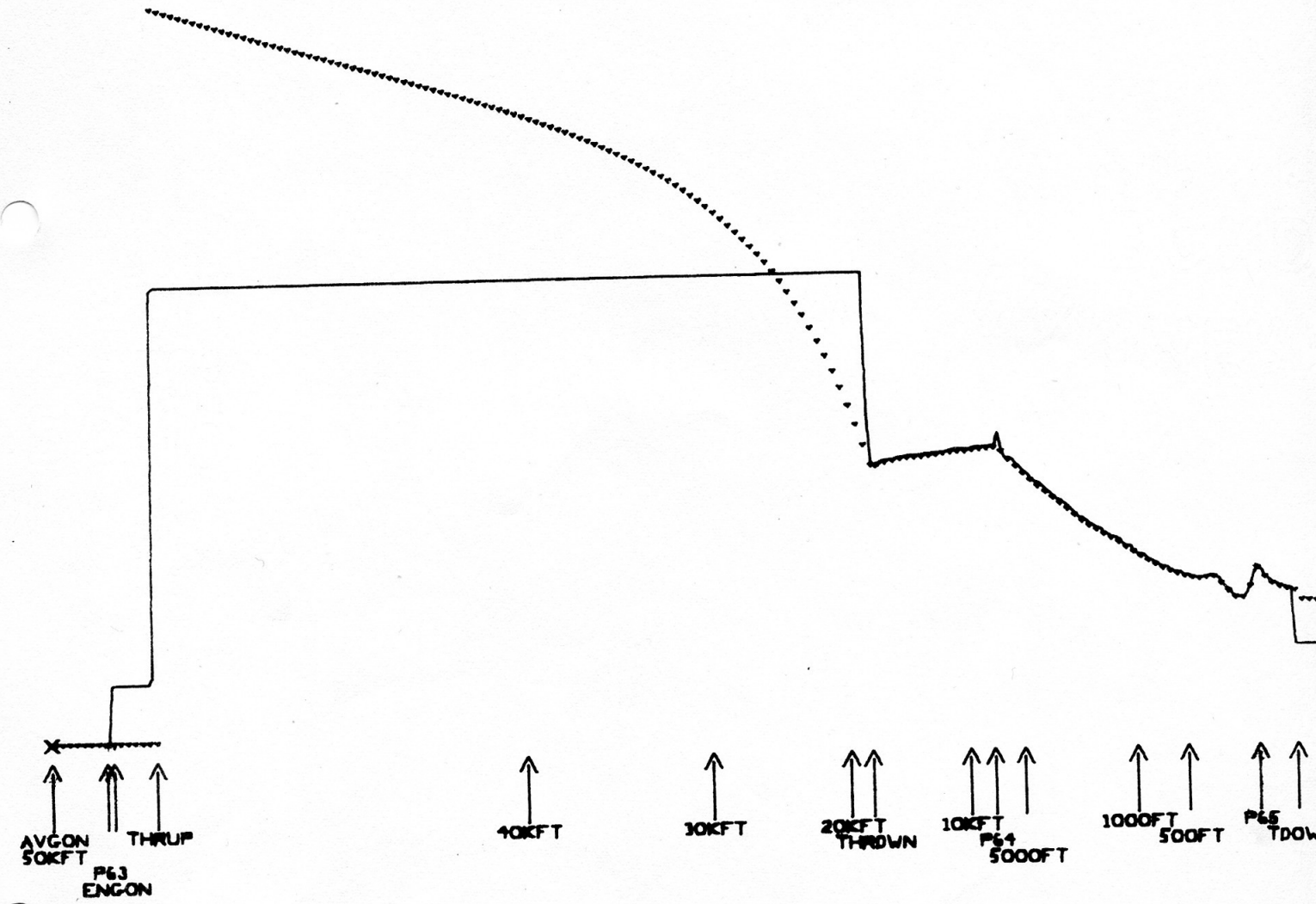
(2) P67 was eliminated. Putting the throttle control switch into manual in P63, P64, P65 or P66 no longer causes a program change. What it does do is cut off the LGC (i.e. auto) throttle signal, and thus engine thrust level will immediately drop to that commanded by whichever hand throttle is alive. This means that a transition from auto-throttle to manual throttle control cannot be smooth: if the switch is put in manual before the manual throttle is brought up, thrust will drop; if the manual throttle is brought up before the switch is switched, since the manual and auto-throttle signals are added, there will be irregular throttling as the LGC corrects for the excessive thrust. To assist the astronaut in following the LGC's thrust command once he has switched over to manual, as the FDAI error needles help him follow attitude command, noun 92 was created containing

R1 THRCMD

R2 HDOT

R3 H

THRCMD is the percent throttle desired by the LGC, based on the DPS rated thrust of 10500 pounds. Half-throttle would look like this: +00050. Thrust and thrust desired for a nominal landing look like this (thrust desired is the dotted line):



During most of P63 more thrust is desired than can be delivered, so don't be surprised when noun 92 shows a THRCMD of 150% or so. HDOT and H occupy the remaining spaces so that when V16N92 is on the DSKY altitude and altitude-rate information is not lost. P67, by the way, is only gone in name: any of the other programs with mode in attitude-hold and throttle in manual is equivalent. Warning: be careful when flying with mode in auto and throttle in manual not to command more thrust than the LGC desires, as this might cause the guidance equations to ask the vehicle to thrust downwards to compensate. For the same reason be careful when switching mode from attitude-hold to auto when the throttle has been under manual control.

(3) VHORIZ, non-directional horizontal velocity, has been replaced in noun 60 (displayed during P65 and P66 and on call in P63 and P64) by forward velocity FORVEL. This minor change came as a result of Armstrong's comment at the debriefing that VHORIZ wasn't of much use.

(4) Finally, it was made possible to bias displayed LPD angles and vehicle yaw to make up for errors in the alignment of the LPD reticle and for window bending when the LM is pressurized. Pad-load erasables AZBIAS and ELBIAS were created overlaying RDOTM - which is okay because there is no **P20 Nav** prior to landing. Both are single precision and scaled in units of half a revolution, the same as CDUs. ELBIAS is added to LPD angle before it is displayed in noun 64: thus if the reticle points too high, ELBIAS should be positive. The value pad-loaded in AZBIAS is added to desired outer gimbal angle in FINDCDUW: if the reticle points too far to the right, AZBIAS should be negative to keep the vehicle yawed left a little. As usual when hardware bugs are

corrected in the software, program elegance suffers. Sympathy is due Allan Klumpp whose subroutine FINDCDUW now has another input OGABIAS to accomodate an outer gimbal angle bias. OGABIAS is filled from AZBIAS during P64 only. OGABIAS is initialized zero in INITCDUW (called by BURNBABY before every burn) so other programs don't have to worry about it. Finally, I should point out that that part of window error which cannot be resolved into rotations about the body y and x axes will remain uncompensated, except at a chosen spot along the reticle, which for the information of the team at GAEC who will compute these numbers should be 42^{o}, the mean LPD angle of the approach phase.